

REMARKS

Claims 1-55 are pending in the application.

Claims 1-55 have been rejected.

Telephone Interview

The undersigned wishes to acknowledge the telephone interview conducted on May 23, 2005 with Examiner Gandhi and SPE Decady and to thank the examiners for their clarification of certain statements and for affording the undersigned an opportunity to distinguish applicant's invention over the cited art. While no agreement was made during the interview, the undersigned believes this paper is in harmony with the positions expressed during the interview.

During the interview, the "Response to Amendment" section (pages 2-3) of the Final Office Action was discussed. In particular, with respect to the arguments about claims 1 and 25 (items 4 and 6 on page 2 of the Final Office Action), the undersigned noted that Shen does not disclose extracting an error polynomial using zero equations and zero branch decisions. The rejection of claim 41 based on the Breiling reference (page 10 of the Final Office Action) was also discussed. The undersigned pointed out that the non-iterative technique disclosed in Breiling appears to only be applicable to turbo decoding systems. More detail regarding these issues is provided below. Finally, during the discussion, SPE Decady mentioned that the examiners would consider withdrawing the finality of the Office Action mailed February 25, 2005.

Rejection of Claims under 35 U.S.C. §102

Claims 1, 5, 9, 10, 11, 12, 25, 30, 31, and 32 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Shen et al (U.S. Pat. No. 6,199,188) (hereinafter referred to as "Shen"). Applicant respectfully traverses this rejection.

As noted in the response submitted on November 8, 2004 (referred to herein as the “prior response”), the cited art fails to anticipate, teach, or suggest: “extracting an error polynomial from the data signal based on no more than six equations having no more than two branch decisions,” as recited in claim 1. The cited portions of Shen are concerned with locating errors within a code word by finding the roots of an error locator polynomial (e.g., see Shen, Abstract and col. 7). With respect to actually generating the error locator polynomial itself, Shen teaches that “the syndrome generator sends the syndromes to an error locator polynomial generator 14, which produces in a conventional manner from the syndromes an error locator polynomial of degree ‘e’, where e is the number of errors in the code word.” Shen does not further elaborate on the “conventional manner” in which the error locator polynomial is produced, and thus Shen clearly fails to anticipate, teach, or suggest generating an “error polynomial” in the manner recited in claim 1. Claims 5, 9, 10, 11, and 12 are patentable over the cited art for similar reasons.

In the Final Office Action, the Examiner states: “As per claim 1, “based on no more than six equations having no more than two branch decisions,” means the number of equations and the branch decisions can be zero. Hence the prior art Shen et al. teaches the limitations of claim 1.” Final Office Action, p. 2. Applicant notes, however, that Shen does not teach extracting an error polynomial from a data signal based on zero equations and zero branch decisions. Instead, as pointed out above, Shen simply teaches that an error locator polynomial is produced “in a conventional manner.” There is no teaching or suggestion in the cited portions of Shen regarding how many equations and branch decisions are involved in producing the error locator polynomial. Since Shen does not teach each and every element of claim 1, Shen does not anticipate claim 1. Accordingly, Applicant requests the withdrawal of this rejection.

As also noted in the prior response, the cited art fails to teach or suggest a system that includes “a plurality of Galois field multiply accumulators; and means for using said Galois field multiply accumulators to generate an error polynomial based on values provided at said syndrome inputs, by executing no more than six equations with two branch decisions,” as recited in claim 25. FIG. 4 of Shen has been cited (on page 4 of the

Office Action mailed August 25, 2004) as anticipating the Galois field multiply accumulators of claim 25. FIG. 4 shows a “subsystem 400 [that] determines the cubic root of an element β in $GF(2^{m+1})$ by raising that element to the power u in multipliers 402, which include of one or more conventional Galois Field multipliers.” Shen, col. 12, lines 30-33. The cubic root of the element β is calculated as part of the process of determining the location of errors, which is in turn based on an error locator polynomial which is “produce[d] in a conventional manner from the syndromes.” Shen, col. 4, lines 40-45, col. 4, line 66 - col. 5, line 8. Thus, the Galois field multipliers of FIG. 4, which are used to raise an element to the power u , clearly neither teach nor suggest using Galois field multiply accumulators to generate an error polynomial, as recited in claim 25. No other cited portion of Shen, either alone or in combination with FIG. 4, teaches or suggests this feature. Instead, the other cited portions of Shen simply describe that an error polynomial can be generated from syndromes (col. 1, lines 53-55), and that “for any degree-three error locator polynomial, $\sigma(x)$, the system determines error locations” (Shen, col. 7, lines 9-10) according to the methodology described in col. 7. Applicant notes that col. 7 is concerned with determining error locations, based on an error locator polynomial, rather than with generating an error locator polynomial itself. Accordingly, the cited art clearly fails to teach or suggest “using said Galois field multiply accumulators to generate an error polynomial based on values provided at said syndrome inputs, by executing no more than six equations with two branch decisions,” as recited in claim 25. Claims 30-32 are patentable over the cited art for similar reasons.

On pages 2-3 of the Final Office Action, the Examiner provides this response to Applicant’s arguments:

“[A]s per claim 25, ‘by executing no more than six equations with two branch decisions’ means zero equation can be executed to generate an error polynomial. Shen et al teach that the mathematical operations of addition, subtraction, multiplication and division discussed herein are Galois field operations over the applicable Galois field (col. 4, lines 32-34, Shen et al.). Shen et al. teach that using the error syndromes, the system determines an error locator polynomial, which is a polynomial that has the same degree as the number of errors (col. 1, lines 53-55, Shen et al.).”

As noted above, Shen does not teach that “zero equation can be executed to generate an error polynomial,” and thus for at least this reason, Shen clearly does not anticipate claim

25. Furthermore, the fact that Shen performs certain mathematical operations as Galois field operations appears to be irrelevant to whether Shen teaches or suggests using Galois field multiply accumulators to generate an error polynomial. In particular, this statement clearly does not show that Shen teaches using Galois field multiply accumulators to generate an error polynomial or generating an error polynomial based on a certain number of equations and branch decisions. For at least the foregoing reasons, Applicant requests the withdrawal of this rejection of claim 25.

Rejection of Claims under 35 U.S.C. §103

Claims 2-4, 6, 13, 14, 18, 24, and 26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Shen in view of Oh et al (U.S. Pat. No. 5,583,499) (hereinafter referred to as "Oh"). Applicants respectfully traverse this rejection.

Claims 2-4 and 6 are patentable by virtue of their dependence upon allowable claim 1. Claim 26 is patentable by virtue of its dependence upon allowable claim 25.

Further with respect to claim 3, Shen and Oh, both alone or in combination, fail to teach or suggest "extracting an error polynomial from the data signal based on no more than six equations having no more than two branch decisions", wherein "said extracting step includes the step of controlling a plurality of Galois field multiply accumulators using a state machine," as recited in claim 3. In particular, as noted in the response submitted November 8, 2004, neither Oh nor Shen teach or suggest the use of state machines and Galois field multiply accumulators to extract an error polynomial.

With respect to claim 13, the cited art fails to teach or suggest calculating a plurality of minimum-degree polynomials associated with the BCH code, using the Galois field multiply accumulators; and generating an error polynomial based on the minimum-degree polynomials, said calculating and generating steps extracting the error polynomial in no more than 12 clock cycles. In particular, as noted in the prior response, neither Shen nor Oh teaches or suggests using Galois field multiply accumulators to calculating a plurality of minimum-degree polynomials, which are then used to generate an error polynomial. As noted above, Shen teaches simply that an error polynomial can

be generated using conventional means. Oh teaches a system that uses an iterative process to calculate an error locator polynomial. Oh states that “an apparatus 1 for updating the error locator polynomial in accordance with the present invention... includes two multiplication blocks 10 and 30, and an addition block 60.” Oh, col. 5, lines 58-62. This apparatus is not a Galois field multiply accumulator, as recited in claim 13. Accordingly, Oh, both alone and in combination with Shen, fails to teach or suggest calculating a plurality of minimum-degree polynomials associated with the BCH code, using Galois field multiply accumulators. For at least this reason, claim 13 is patentable over the cited art. Claims 14, 18, and 24 are patentable over the cited art for at least the foregoing reasons provided with respect to claim 13.

In response to Applicant's above arguments, the Examiner again cites the portions of Shen stating that certain mathematical operations are Galois field operations. Final Office Action, p. 2. However, the mere fact that Shen states that, as used within Shen, certain mathematical operations are Galois field operations does not provide any teaching or suggestion regarding how an error locator polynomial can be generated (again, as noted above, Shen simply says that an error locator polynomial is generated using “conventional means”). Furthermore, such a statement does not provide any teaching or suggestion regarding the use of Galois field multiply accumulators to generate minimum-degree polynomials associated with a BCH code.

Page 2 of the Final Office Action also cites Figs. 1A-1C of Oh, which show flowcharts of an iterative technique for generating an error locator polynomial using the Berlekamp-Massey algorithm, the Liu algorithm, and the invention disclosed in Oh. Oh, col. 3, lines 22-25. Additionally, the Final Office Action cites col. 5, lines 46-48 of Oh, which recite: “It can be easily seen that $4t$ multipliers in the Galois field are needed and each iteration is completed in 2 clock cycles in the case of the present algorithm.” This statement refers to the implementation of the flowchart of Fig 1C, which depicts the calculation of a discrepancy d_n , a temporal term $T_n(x)$, a modified correction term $C_n(X)$, and the error locator polynomial $\sigma_n(X)$. Oh, col. 5, lines 17-20. Thus, while Oh does provide teachings relevant to the use of multipliers in the calculation of an error locator polynomial, the cited portions of Oh, both alone and in combination with the cited

teachings of Shen, provide no teachings or suggestions relating to the calculation of a plurality of minimum-degree polynomials associated with a BCH code, using Galois field multiply accumulators. For at least the foregoing reasons, Applicant requests the withdrawal of this rejection of claim 13.

Claim 7 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Shen in further view of Erhart et al (U.S. Pat. No. 5,051,999). The rejection relies on the same rationale as the 102(e) rejection of claim 1. Accordingly, claim 7 is patentable over the cited art for at least the reasons provided above with respect to claim 1. Furthermore, Erhart, either alone or in combination with Shen, does not teach or suggest “extracting an error polynomial from the data signal based on no more than six equations having no more than two branch decisions,” as recited in claim 1.

Claims 8, 27-29, and 33-37 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Shen in view of Stenerson (U.S. Pat. No. 4,597,083) (hereinafter referred to as “Stenerson”). Claim 8 is patentable over the cited art for reasons similar to those provided above with respect to claim 1. Claims 27-29 and 33-37 are patentable over the cited art for reasons similar to those provided above with respect to claim 25.

Claims 15-17, 19, 20, 21, 22, 23, 40, 43, 44, and 45 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Shen and Oh in view of Stenerson. Claims 15-17, 19, and 20-23 are patentable over the cited art for reasons similar to those provided above with respect to claims 2 and 13. Claims 40 and 43-45 are patentable over the cited art for reasons similar to those provided above with respect to claim 38.

Further with respect to claim 19, the cited art fails to teach or suggest computing a first correction term using at least one of the Galois field multiply accumulators, the first correction term being equal to a first one of the syndromes; computing a second correction term using at least one of the Galois field multiply accumulators, the second correction term being equal to the sum of a product of the first syndrome with a second

one of the syndromes, and a third one of the syndromes; and computing a third correction term using at least one of the Galois field multiply accumulators, the third correction term being based in part on coefficients of at least one of the minimum-degree polynomials.

In the Office Action mailed August 25, 2004, the Examiner cites Stenerson as teaching “the first correction term being equal to a first one of the syndromes.” However, the cited portions of Stenerson simply recite: “Assuming one error at location j , the error value e_j in relation to each syndrome is, from Equation (14): $S_{127} = e_j \alpha^{127j}$,” Stenerson, col. 9, lines 44-46; and “The Galois field products from the multiplier 124 (in the form of a PROM programmed as shown in FIGS. 18C and 18D corresponding to multiplying by α , the coefficient of the fourth term of the polynomial) are summed by exclusive-ORs 132 with the corresponding outputs of the latches 130,” Stenerson, col. 18, lines 28-33. These portions of Stenerson appear to be unrelated to the calculation of a first correction term, as recited in claim 19. Neither these portions of Stenerson nor any other cited portion of any of the other references cited against claim 19, alone or in combination, teaches or suggests “the first correction term being equal to a first one of the syndromes.” Thus, for at least this reason, claim 19 is patentable over the cited art.

Claims 38 and 40 are rejected under U.S.C. § 103(a) as being unpatentable over Patel (U.S. Pat. N. 4,504,948) (hereinafter referred to as “Patel”) in view of Stenerson. With respect to claim 38, the cited art fails to teach or suggest a plurality of Galois field multiply accumulators and a state machine programmed to use said Galois field multiply accumulators to generate an error polynomial based on the following six equations:

$$(1) d_0 = S_1,$$

$$(2) d_1 = S_3 + S_1 S_2,$$

$$(3) \sigma^1(X) = 1 + S_1 X,$$

$$(4) \text{ if } (d_1 = 0) \text{ then } \sigma^2(x) = \sigma^1(x)$$

$$\text{else if } (d_0 = 0) \text{ then } \sigma^2(X) = q_0 \sigma^1(X) + d_1 X^3$$

$$\text{else } \sigma^2(X) = q_0 \sigma^1(X) + d_1 X^2,$$

$$(5) \ d_2 = S_5\sigma_0 + S_4\sigma_1 + S_3\sigma_2 + S_2\sigma_3, \text{ and}$$

$$(6) \text{ if } (d_2 = 0) \text{ then } \sigma^3(X) = \sigma^2(X)$$

$$\text{else } \sigma^3(X) = q_1\sigma^1(X) + d_1X^3,$$

where S_i are error syndromes, σ^i are minimum-degree polynomials, σ_i are four coefficients for $\sigma^2(X)$, d_0 - d_2 are correction factors, q_0 - q_1 are additional correction factors, q_0 is equal to d_0 unless d_0 is zero, when q_0 is 1, and q_1 is equal to d_1 unless d_1 is zero, when $q_1 = q_0$.

On page 5 of the Final Office Action, portions of columns 4-5 and 7-10 of Patel are relied upon to teach the equations of claim 38. While these portions of Patel do show several equations used to generate an error polynomial, the cited portions of Patel do not show the particular equations recited in claim 38. Furthermore, no explanation of how or why the equations of Patel correspond to the equations of claim 38 has been provided. None of the cited portions of Stenerson, either alone or in combination with the cited portions of Patel, provide any teachings or suggestions related to such equations. Accordingly, the cited art fails to teach or suggest the particular equations recited in claim 38. Claim 40 is also patentable over the cited art for at least these reasons.

Claims 39, 46, and 47 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Patel in view of Stenerson and further in view of Maki et al (U.S. Pat. No. 4,873,688). These claims are patentable over the cited art for at least the reasons provided above with respect to claim 38.

Claim 41 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Patel and Oh in view of Wolf (U.S. Pat. No. 6,385,751). This claim is patentable over the cited art for at least the foregoing reasons provided above with respect to claim 38.

Claims 42-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Patel and Stenerson in view of Shen. These claims are patentable over the cited art for at least the foregoing reasons provided above with respect to claim 38.

Claim 48 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Alvarez et al (U.S. Patent Pub. 2002/0165962) (hereinafter referred to as "Alvarez") in view of Oh and Breiling et al. (the article entitled "Optimum non-iterative turbo-decoding," hereinafter referred to as "Breiling"). Applicant respectfully traverses this rejection.

As noted in the prior response and recognized on page 10 of the Final Office Action, the combination of Alvarez and Oh fails to teach or suggest means for decoding error-correction codes embedded in each of the four OC-48 signals, said decoding means including means for generating an error polynomial associated with a given one of the error-correction codes in no more than 12 clock cycles, wherein said decoding means uses a non-iterative algorithm to generate the error polynomial. The rejection relies on Breiling to teach this feature of claim 48.

Breiling teaches a non-iterative technique, based on a super-trellis structure, for use in a turbo decoding system. Breiling, Abstract. There is no suggestion to combine Breiling's teachings with Alvarez and Oh. The stated motivation to combine Breiling's turbo decoding teachings with Alvarez and Oh is that using "a non-iterative algorithm to generate the error polynomial would provide the opportunity to reduce Gaussian channel signal-to-noise ratio." Final Office Action, p. 10. However, the Examiner has not explained why Gaussian channel signal-to-noise ratio reduction would be desirable in error polynomial generation, nor has the Examiner explained how such a reduction would be achieved by the combination (the Abstract of Breiling simply notes that use of the proposed turbo decoding algorithm requires a lower Gaussian channel signal-to-noise ratio than another turbo decoding algorithm, not that the new turbo decoding algorithm provides any such reduction). Since there is no suggestion to combine the references, a *prima facie* case of obviousness has not been established. For the foregoing reason, Applicant asserts that claim 48 is patentable over the cited art.

Furthermore, Breiling's techniques appear to be specific to the context of turbo decoding systems. No teaching or suggestion has been provided to explain how one of ordinary skill in the art would successfully combine such turbo decoding techniques with the systems taught in Alvarez and Oh. Accordingly, Applicant asserts that the Examiner has not shown that one of ordinary skill in the art would have a reasonable expectation of successfully combining Breiling's non-iterative turbo-decoding technique with the teachings of Alvarez and Oh. This further shows that no *prima facie* case of obviousness has been established.

Additionally, as noted in the prior response, there is no suggestion to combine Alvarez and Oh. "To support the conclusion that the claimed combination is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed combination or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references... [S]implicity and hindsight are not the proper criteria for resolving the issue of obviousness." *Ex Parte Clapp*, 227 U.S.P.Q. 972, 973 (Bd. Pat. App. & Int'f 1985). There is no mention of decoding error-correction codes in Alvarez, nor is any need for such error-correction codes mentioned. Similarly, Oh does not suggest that the error correction techniques taught in Oh would be useful in the particular system taught in Alvarez. The stated reason for the combination of the references is that "one of ordinary skill in the art would have recognized that it would provide the opportunity to reduce the time required to determine the locations of the errors." Final Office Action, page 10. However, given that there is no mention of code words in Alvarez, let alone a mention of a need to reduce the time required to determine error locations, this statement does no appear to correspond to the teachings of the cited art. Accordingly, Applicant respectfully requests the withdrawal of this rejection.

Claims 49-50 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Alvarez and Oh in view of Breiling. These claims are patentable over the cited art for at least the foregoing reasons provided above with respect to claim 48.

Claims 51-53 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Alvarez, Oh, and Breiling in view of Stenerson and Shen. These claims are patentable over the cited art for at least the foregoing reasons provided above with respect to claim 48.

Claim 54 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Alvarez, Oh, and Breiling in view of Shen. This claim is patentable over the cited art for at least the foregoing reasons provided above with respect to claim 48.

Claim 55 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Shen in view of Breiling. This claim is patentable over the cited art for at least the foregoing reasons provided above with respect to claim 1.

CONCLUSION

In view of the amendments and remarks set forth herein, the application and the claims therein are believed to be in condition for allowance without any further examination and a notice to that effect is solicited. Nonetheless, should any issues remain that might be subject to resolution through a telephonic interview, the Examiner is invited to telephone the undersigned at 512-439-5087.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Mail Stop AF, COMMISSIONER FOR PATENTS, P. O. Box 1450, Alexandria, VA 22313-1450, on May 25, 2005.

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5-25-2005

Date of Signature

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